X-OE-905
Revision 4

SYSTEM REQUIREMENTS DOCUMENT

FOR THE

CENTER FOR NANOPHASE MATERIALS SCIENCES

July 19, 2004
Revision 4

Prepared by:

Oak Ridge National Laboratory

Oak Ridge, Tennessee

System Requirements Document

For

CENTER FOR NANOPHASE MATERIALS SCIENCES

Conventional Facilities Project Manager

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ACRONYMS

AC	alternating current
ADA	Americans With Disabilities Act
ALARA	as low as reasonably achievable
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-conditioning Engineers
CLO	Central Lab and Office Building
cm	centimeter
CNMS	Center for Nanophase Materials Sciences
DOE	Department of Energy
EMF	electromagnetic field
EMI	electromagnetic interference
EVA	EMI, vibration and acoustic sensitivity
F	Fahrenheit
ft	feet
H&V	heating and venting
HEPA	high efficiency particulate air
HVAC	heating, venting, and air conditioning
IBC	International Building Code
NRL	Nanofabrication Research Laboratory
ORNL	Oak Ridge National Laboratory
PC	performance category
psf	pounds per square foot

psig	pounds per square inch - gauge
R	inelastic code reduction factor
RH	relative humidity
SNS	Spallation Neutron Source
STD	standard
TMS	theory/modeling/simulation
UL	Underwriters Laboratory
UPS	uninterrupted power supply
v	volt

SYSTEM REQUIREMENTS DOCUMENT FOR THE CENTER FOR NANOPHASE MATERIALS SCIENCES

1.0 PROJECT MISSION

The mission of the Center for Nanophase Materials Sciences (CNMS) is to provide a user facility for the research, design, modeling, synthesis, processing, fabrication, and characterization of novel molecular and nanoscale materials.

2.0 INTRODUCTION

The Oak Ridge National Laboratory (ORNL), with extensive input from the academic community, will establish the highly collaborative and multidisciplinary CNMS that will provide a unique resource for nanoscale science research. It will uniquely integrate nanoscale science research with neutron science, synthesis science, and theory/modeling/simulation (TMS).

The CNMS's three major scientific thrusts will be in nano-dimensioned soft materials, complex nanophase materials systems, and TMS and include the crosscutting areas of interfaces and reduced dimensionality that become scientifically critical on the nanoscale. A major focus of the CNMS will be to exploit ORNL's unique capabilities in neutron scattering provided by the new Spallation Neutron Source (SNS) and the upgraded High Flux Isotope Reactor to determine the structure of nanomaterials, to understand synthesis and self-assembly processes in soft materials, and to study collective (cooperative) phenomena that emerge on the nanoscale.

3.0 SYSTEM DESCRIPTION

The CNMS facility will consist of a multistory building including the main lab and office building and an attached single story Nanofabrication Research Laboratory (NRL). The NRL will be built using a construction approach that will meet low electromagnetic field, vibration, and acoustic noise requirements for the instrumentation. The CNMS will be located adjacent to the Central Lab and Office Building (CLO) at the SNS. The CNMS will house the core support facilities, offices, and laboratories necessary to fulfill its mission. The facility will house approximately 190 people. Included also will be the equipment necessary to synthesize, manipulate, and characterize nanoscale materials and structures. See attachment 7.1 for the list of technical equipment.

The CNMS will have multistory office facilities, dry laboratories, wet chemistry laboratories, common and core space, and the single story NRL, with approximately 80,000 gross square feet. The NRL will integrate the use of "hard" and "soft" materials in nanofabrication research and will contain clean rooms, an electron beam lithography facility and high-resolution analytical equipment. The NRL will have ISO Class 8, ISO Class 7, ISO Class 6, and ISO Class 5 clean areas per ISO Standard 14644-1 (formally class 100,000, class 10,000, class 1,000, and class 100 per Federal Standard 209D) The office facilities will provide office space for research and professional staff members, visiting research staff members, support staff, and guests.

The laboratory spaces will consist of dry laboratories and wet chemistry laboratories, with additional analytical and nanofabrication laboratories in the NRL. The laboratories will be used for materials science research. The common spaces consist of conference rooms, rest rooms, hallways, storage areas, and equipment space. The core space includes mechanical, electrical, and telecommunications equipment rooms and chases and a computer hardware room.

4.0 SYSTEM REQUIREMENTS

The CNMS shall be designed and constructed to provide for flexibility, versatility, durability, and longevity. The interior of the facility shall facilitate dynamic changes in the scientific programs associated with the CNMS and shall require minimal modification and relocation to accommodate new programs and personnel. Construction materials and technology shall be used that will provide structures with a lifetime of thirty years without major renovation.

Sustainable building design principles shall be evaluated and cost effective features applied to the design and construction of the CNMS. Standard practices, which include using recycled content products, purchasing energy efficient and water efficient material and equipment (Energy Star) and substituting less hazardous construction materials shall be used where economically feasible.

All design and construction requirements and activities shall be in compliance with the CNMS Codes and Standards (X-0E-918). It should be noted that for design and construction the CNMS Codes and Standards and the ORNL Work Smart Standards are identical.

4.1 General Requirements

4.1.1 Structural and Architectural

- provide support, enclosure, and protection for equipment and personnel housed within their confines from normal environmental conditions and from natural phenomena events (seismic, wind, and flood).

- the buildings shall meet seismic, wind, and flood requirements for performance category PC-1 as outlined in DOE STD 1020-02. The 1999 Standard Building Code shall be the structural code of record. Wind design shall be per ASCE 7-98 and based on a wind speed (gust) of 90 mph with exposure C and an importance factor of 1.0. Seismic design shall be per the 2000 International Building Code (IBC) using Seismic Group I and an importance factor of 1.0. Load combinations shall be in accordance with IBC.

- provide access accommodations for the physically disabled into the user areas, labs, restrooms, and office spaces in accordance with the Americans With Disabilities Act (ADA).

- the architecture of the CNMS shall emulate and complement the CLO.

- provide floors designed to safely support the live loads prescribed in ASCE-7 based on the intended occupancy or use, unless heavier loads for equipment or material handling are encountered such as for the B1 and 1st floors where the minimum live load shall be 250 psf.

- provide significant buildings and structures with noncombustible or fire resistive construction materials that minimize susceptibility to fire loss.

- provide diking or remote impounding, whichever is most practical, in buildings used for the storage or processing of hazardous material to prevent/minimize the release of contaminated fire fighting water to the environment during a fire incident.

- provide buildings and other structures with sufficient physical separation to prevent a fire in one structure from spreading to another; in cases where physical separation is not practical, fire barriers will be provided.

- provide fire rated walls to separate hazardous equipment/operations where desirable or required; e.g., electrical transformers inside buildings shall be dry type or separated with 2-hour firewalls.

- construct all firewalls in accordance with Underwriters Laboratory (UL) listed assemblies; penetrations through firewalls will be sealed with UL-listed or Factory Mutual approved fire stop configurations.

- provide travel distances and egress configurations for all buildings and structures to ensure the prompt and safe evacuation of building occupants in the event of an emergency.

- ensure building/area access restrictions (safety/security badge readers, etc.) do not interfere with life safety emergency egress requirements.

- provide, if practical, a dedicated room for the sprinkler systems risers whose door is accessed from an outside wall and is readily visible from the building fire access lane.

- provide adequate manufacturer-recommended service access and replacement clearance for equipment.

- there shall be no outside windows in the laboratories.

- there shall be no speed bumps or bridges near the facility to minimize vibration

4.1.2 Electrical Power and Communications Systems

Electric Power

- provide building electrical power systems to receive electrical power from the site electrical distribution and supply the maximum design facility electrical load.

- provide emergency on-site AC power supplies and uninterrupted power supply (UPS) systems to power loads that must remain operable in the event of loss of off-site power.

- Provide motor-generator sets to power all Electro Magnetic Interference, Vibration and Acoustic (EVA) sensitive equipment in the NRL; installation of motor-generator sets shall meet the requirements identified in IEEE 446-1995, Emergency and Standby Power Systems for Industrial and Commercial Application and IEEE 1100-1999, Powering and Grounding Electronic Equipment.

- provide facility electrical power systems to prevent the adverse effects of under- and over-voltages and over-currents from damaging structures, systems, and components.

- provide facility electrical power systems designed to mitigate the effects of power harmonics produced by non-linear loads on both the electrical distribution equipment and other loads on the system; power quality shall meet the requirements identified in IEEE 519-1992, "Recommended Practice and Requirements for Harmonic Control in Electric Power Systems".

- provide selective and coordinated protection for the power distribution system by proper application of protective relays and active tripping devices.

- provide microprocessor-based meters for measuring and recording electric energy use at the incoming power service to the buildings and at the internal service points of significant process loads as required by 10CFR435. The building electrical distribution system shall be equipped with an integrated microprocessor-based metering, protection, and control system. This system shall collect information from the distribution system to allow real-time monitoring and control from a central location. As a minimum, all switchgear, unit substations, and motor control centers shall be equipped with microprocessor-based metering, protection, and control devices, and must be able to interface with the SNS Global Control System with a sufficient sampling rate so that harmonics can be measured.

- provide an electrical system that is capable of effective and efficient lockout and tag-out.

Lighting

- provide the necessary illumination of facility components, facilities, and control locations of a quantity and quality adequate to permit satisfactory performance of the required visual tasks.

- provide emergency lighting systems for egress lighting during building power outages.

Grounding and Electrical Protection

- effective grounding of systems and equipment shall be provided to ensure personnel safety and equipment protection.

- provide protection against lightning-induced and switching transients to ensure proper operation of electrically energized equipment and to ensure the reliable operation of building systems.

- provide an insulated single-point instrumentation ground system to ensure effective noise reduction for analog and digital instrument signals in accordance with IEEE 1100-1999, "Recommended Practice for Powering and Grounding Electronic Equipment".

Raceway System

- provide for routing of feeders to all facility loads.

- provide separated raceways for signal and power wiring.

- overhead cable trays and the associated supports that can fall and injure personnel shall be designed to safely withstand all applicable seismic forces as required by DOE Standard 1020-02, IBC – 2000, for a PC-1 classification.

Fire Alarm System

- provide an addressable protected premises fire alarm system for the facility as a part of the site-wide SNS fire alarm system. All fire alarm and supervisory devices shall report to a local fire alarm control panel at the protected premises. This fire alarm control panel shall sound an alarm at the protected premises and transmit the fire alarm/supervisor signal to the proprietary supervising station at ORNL Building 2500. All signals shall also be sent to the SNS Central Control Room.

- provide manual and automatic fire detection and alarm initiation devices as required to meet life safety criteria or meet enhanced property protection requirements as defined in the building Fire Hazards Analysis.

- provide fire alarm evacuation signals throughout the facility. Evacuation signals shall be audible, and, where applicable, visible type notification devices.

- provide appropriate protection for special hazards in accordance with applicable codes and as defined in the building Fire Hazards Analysis.

Electrical Power, Control, Instrumentation and Communications Systems Cabling Requirements

- provide wiring for all conventional facility power loads and control devices.

- provide copper wiring for interior electrical systems.

- provide multiconductor cable for control and instrumentation wherever practical.

- provide twisted pair copper cable certified for Category 5 applications in accordance with EIA/TIA 568-A Standard for telephone service to communications outlets.
- provide twisted pair copper cable certified for Category 6 (minimum) applications in accordance with EIA/TIA 568-A Standard for data service to communications outlets.

Telecommunications Systems

- provide the necessary equipment and cabling to support basic telephone communication throughout the building.

- ensure the ORNL emergency public address system shall have the capability to override the local facility public address system.

Data Communications System

- provide high speed communications hardware and a wiring infrastructure to allow for a high speed data transfer network.

- provide fiber optic communications service from the SNS Site Communications System to the CNMS Communications Center and from the CNMS Communications Center to the communications rooms on each floor of the CNMS and to the communications room of the NRL.

- terminate all communications cabling on each floor in the communications room located on that floor.

4.1.3 Environmental Control Systems

- cooling shall be provided using site chilled water, additional chillers shall be added at the central utility building if the site chilled water capacity is not adequate.

- buildings shall be zoned in an energy-efficient manner consistent with the operating characteristics and efficiencies of the system selected.

- air conditioning systems serving labs shall not serve other types of spaces.

- ancillary equipment, such as pumps, blowers, motors, compressors, gear trains, and controls shall be located to minimize noise and vibration transmission.

- building heating and cooling load calculations for the office type spaces (i.e., offices, conference rooms, hallways, storage areas, equipment spaces, computer rooms, telecommunications equipment rooms, etc.) and the laboratories in the multistory facility shall be predicated on the meteorological conditions provided in the 1997 ASHRAE Fundamentals Handbook for the Knoxville area. Criteria for the heating season are defined by the data provided for the 99.6% annual cumulative frequency of occurrence for dry bulb temperatures and by the 0.4% occurrence data for wind speed. Summer conditions are

defined by the data for the 0.4% occurrence frequency for dry bulb temperatures and the mean coincident wet bulb.

- cooling load calculations for the clean rooms in the single story NRL shall use a summer outside design conditions of 93^{o}F DB and 79^{o}F WB.

- air-cooled condensers and condensing units shall be rated based on an ambient dry bulb of 98^{O}F.

- outside air shall be introduced as necessary to meet the minimum requirements for acceptable air quality per ASHRAE Standard 62 or as required to meet exhaust requirements, whichever is greater.

- dilution ventilation systems shall be designed to limit the rise of space temperatures to 10^{O}F greater than ambient and spaces, which are only heated, shall be maintained at a minimum temperature of 68^{O}F.

- energy conservation shall be an integral part of the design process and shall comply with 10CFR435.

- energy conserving design practices shall be used to the extent allowed by the environmental control tolerances required.

- microprocessor based DDC systems shall be used to monitor and control HVAC equipment. The HVAC DDC system for the CNMS facility shall be an expansion of and compatible with the DDC system that will be installed in the CLO facility.

- office areas and labs in the 4 story facility shall be air conditioned to maintain 74$\pm$2^{O}F during the cooling season and 70$\pm$2^{O}F during the heating season. Office areas shall be designed using an indoor relative humidity of 55% RH; however, the humidity in the office and lab areas shall not be controlled.

- filtration efficiency for the air handling systems in the multistory facility shall be at least 60% unless otherwise indicated.

- overhead mechanical piping, ductwork, and their associated supports that can fall and injure personnel shall be designed to safely withstand all applicable seismic forces as required by DOE Standard 1020-02, IBC – 2000, for a PC-1 classification.

- exhaust air from the laboratory spaces shall be HEPA filtered as identified in Attachment 7.2, CNMS Lab Equipment and Utilities Requirements, prior to discharging to the atmosphere.

4.1.4 Mechanical/Piping Systems

- the potable water system shall supply potable water to all water fixtures in lunchrooms, showers, rest rooms, drinking fountains, safety showers, and other areas and firewater distribution to all fire hydrants and fire suppression and standpipe systems.

- the potable water system will be valved so that the domestic and process systems can be shut down without shutting off the fire system supply or safety shower systems.

- provide a process water system supplied by the potable water system and separated from it by listed backflow prevention devices.

- provide a deionized water system that supplies adequate deionized water that meets the Type II requirements of ASTM D 1193-91 (1 Mohm resistivity) for the main lab and office building, deionized water shall also be supplied to the Nanofabrication Research Laboratory and be polished to meet Type I requirements of ASTM D 1193-91 (18 Mohm resistivity).

- the chilled water system shall be supplied from the site system and shall provide chilled water at sufficient flow, pressure, and temperature to service the building HVAC system as required.

- provide a closed loop process cooling system, served by the chilled water system, to provide cooling for the lab and technical equipment.

- the sanitary waste lines shall be tied into the site sanitary waste system.

- the compressed air system shall be supplied from the site system and provide pressurized, clean, dry, oil-free air at a minimum of 100 psig and at the proper quantity and quality to instruments, pneumatic devices, and service air outlets throughout the buildings.

- process waste systems shall be provided as needed. The process waste collection system shall route process waste to the site process waste system. Acid waste will be neutralized locally in each lab prior to pouring down the sink drain, or acid waste will be collected for disposal as hazardous waste.

- floor drains in labs areas shall be routed to the process waste system.

- gases such as helium will be provided from cylinders.

- nitrogen gas shall be supplied as required from the exterior liquid nitrogen tank.

- the buildings shall be protected by automatic fire suppression systems. The preferred method of automatic suppression is the wet pipe sprinkler system. Other types of suppression systems may be used as necessary.

- overhead mechanical piping, and the associated supports that can fall and injure personnel shall be designed to safely withstand all applicable seismic forces as required by DOE Standard 1020-02, International Building Code – 2000, for a PC-1 classification

4.2 Building Specific Requirements

4.2.1 Main Lab and Office Building

- the main building shall provide office space using a combination of hard-walled offices and cubicles.

- construction shall be structural steel framing with concrete floor slabs.

- the 1st, 2nd and 3rd floor of the CLO shall be connected by an enclosed walkway to the corresponding floor of the CNMS to provide easy access to the CLO and the bridge from the CLO to the Target Building. Sidewalks and plazas shall be provided to connect the building with the CLO and parking areas.

- a room shall be provided for building computers and servers.

- Each office shall have two internet connections and a phone connection.

- conference rooms shall be provided based on the size and use of the facility.

- the building shall have rest rooms, hallways, storage areas, and other equipment space as appropriate.

- the building shall have a loading dock sufficient for the receipt and shipment of gas cylinders, chemicals, and other materials.

- two equipment staging rooms shall be provided, one for the Main Labs and one for the NRL.

- a storage area for both empty and full gas cylinders shall be located immediately adjacent to the loading dock.

- ORNL will lease an external ground-level liquid nitrogen storage tank.

Dry Laboratories

- the building shall have dry laboratories in addition to those in the NRL. Each laboratory shall have an eye wash unit and safety shower. See attachment 7.2 for a description of equipment and utility requirements for the labs.

- each lab shall have a minimum ceiling height of 13 ft. Structural supports and utilities may infringe in this area with a minimum clearance of 10 ft.

- each lab shall have fluorescent lighting with a minimum floor to light clearance of 9 1/2ft.
- electrical service shall provide three phase 480 v and 208/120 Y v.
- 120 v and 208 v electrical outlet strip on the walls shall be provided.
- each lab floor shall have a center floor drain.
- each lab shall have two overhead snorkel exhaust connections located on the ceiling centerline approximately at the ¼ and ¾ location along the long dimension of the room.
- each lab shall be served by a compressed air system that provides a continuous supply of oil-free, clean, dry air at no less than 100 psig with a dew point not higher than -40^{O}F.
- sinks and hoods shall be provided as required by attachment 7.2.
- each lab shall have four internet connections and two phone connections.
- each lab shall have minimal built-in casework only as necessary for sinks and hoods.
- lab floors shall have chemical resistant flooring

Wet Laboratories

- the building shall have wet chemistry laboratories in addition to those in the NRL. Each laboratory shall have an eye wash unit and safety shower. See attachment 7.2 for a description of equipment and utility requirements for the labs.
- each lab shall have a minimum ceiling height of 13 ft. Structural supports and utilities may infringe in this area with a minimum clearance of 10 ft.
- each lab shall have fluorescent lighting with a minimum floor to light clearance of 9 1/2 ft.
- electrical service shall provide 480 v and 208/120Y v.
- 120 v and 208 v electrical outlet strip on the walls shall be provided.
- each lab floor shall have a center floor drain.
- sinks and hoods shall be provided as required by attachment 7.2.

- each lab shall have two overhead snorkel exhaust connections located on the ceiling centerline approximately at the ¼ and ¾ location along the long dimension of the room.

- each lab shall be served by a compressed air system that provides a continuous supply of oil-free, clean, dry air at no less than 100 psig with a dew point not higher than -40^{O}F.

- each lab shall have four internet connections and two phone connections.

- each lab shall have minimal built-in casework, only as necessary for sinks and hoods.

- lab floors shall have chemical resistant flooring

4.2.2 Nanofabrication Research Laboratory

- floor/foundation construction shall be a slab-on-grade of sufficient thickness and mass to dampen vibration as required for operation of the research instruments.

- rebar in the base slab shall be epoxy or vinyl coated and connected with non-conducting ties.

- wall (interior and exterior) and roof construction shall be of materials that support meeting the electromagnetic field (EMF), vibration, and noise requirements. Gypsum drywall shall not be used.

- the EMF shall not exceed 0.1 milligauss in the clean rooms.

- each lab shall be served by a compressed air system that provides a continuous supply of oil-free, clean, dry air at no less than 100 psig with a dew point not higher than -40^{O}F, filtered to 1 micron.

- provide ISO Class 8, ISO Class 7, ISO Class 6, and ISO Class 5 clean spaces in accordance with ISO Standard 14644-1 (formally class 100,000, class 10,000, class 1,000, and class 100 per Fed Std 209D) within the central portion of the NRL, as required to support the technical equipment. The clean room design, construction, and start-up shall be in accordance with the requirements of ISO Standard 14644-4.

- The temperature and humidity for the clean rooms shall be maintained at 68 ± 1^{O}F and $55 \pm 5\%$ RH during all seasons.

- semiconductor industry standard clean room fans and ducts shall be used in the NRL.

- Clean room bays shall have eight internet connections and a phone connection; the microscope rooms and gowning area shall have two internet connections and a phone connection.

- clean room entrances shall have appropriate access controls and a gowning area.

- all clean room flooring and perimeter walls shall be fabricated to meet anti-static material control requirements.

- clean room ceilings, walls, and floors shall be constructed to allow for appropriate ventilation, filtering, temperature, and humidity controls.

- One laminar and one regular flow hood shall be provided in the photolithography bay, the E-beam lithography bay and the thin film bay. Provisions shall be provided for a future hood in the thin film bay.

60 Hertz EMF Minimization in Electron Microscope and Electron Beam Writer Rooms

- maximize the use of non-metal structural elements such as PVC, fiberglass, concrete, masonry, etc. For masonry walls, reinforce and grout only those cores necessary to satisfy seismic and wind criteria.

- where magnetic metal is used in building piping and HVAC systems and in support structures and equipment, isolate/insulate the metal to prevent the flow of ground electrical current.

- minimize the use of magnetic metal HVAC ductwork and piping. When magnetic metal ducts and/or piping must be used, use dielectric breaks (plastic couplings, etc.) where appropriate.

- isolate the electrical distribution system from concrete slabs by using PVC conduit and nonmetallic electrical raceways.

- where magnetic metal is present in equipment supplied with electrical power, isolate /insulate the metal such that any ground current is returned through the electrical equipment grounding conductor rather than through any building metal systems.

- utilize rigid non-metallic raceways, junction boxes, and outlet boxes where possible so that ground current cannot flow in the electrical raceway system.

- make provisions in the electrical distribution system to detect any neutral to ground connections.

- minimize the use of electrical equipment and raceway systems that separate the phase and neutral conductors.

- twist the phase, neutral and ground conductors in raceways and wire-tie them together.

- install a separate neutral conductor for each phase conductor (don't use a common neutral for 1 phase 3 wire or 3 phase 5 wire systems). Provide separate ground wires.

- run a neutral wire along with each phase conductor to each light switch.

- locate concentrated electrical loads such as transformers, motors, etc away from the electron microscope areas.

- locate sources of acoustic and/or vibrational noise away from the electron microscope areas.

- Minimize vibration due to footfalls in the corridors adjacent to the electron microscope areas.

- segregate electrical loads on separate circuit breakers such that electrical branch circuit wiring can be de-energized when not in use.

- provide only the minimum electrical service required by each lab. Avoid running electrical service through one lab to another.

- provide clean power to all electron microscopes and the electron beam writer.

5.0 INTERFACES

The interface where the CNMS receives utility services from the SNS shall occur where the CNMS-specific line taps into the SNS utility system. The actual connection shall be the responsibility of the CNMS.

6.0 UNCERTAINTIES AND ANALYSES

7.0 ATTACHMENTS

7.1 CNMS Equipment List

7.2 CNMS Lab Equipment and Utility Requirements

Soft Materials Characterization
Gel Permeation Chromatography (GPC) and High Temperature GPC with Light Scattering Detector
UV–Vis Spectrophotometer
Fourier Transform Infrared Spectrometer (FTIR)
Matrix–assisted laser desorption/ionization time–of–flight mass spectrometer (MALDI–TOF–MS)-benchtop
Physical characterization of polymers
Surface Analysis Equipment: Ellipsometer
Simultaneous Static and Dynamic Light Scattering Spectrometer

Nanophase Materials Synthesis And Characterization Equipment
MOPO and YAG Laser Systems
Continuous Wave (CW) Ti-sapphire Ring Laser
Tunable Raman Spectrometer
4-probe transport Scanning Tunneling Microscope
High–resolution Spin–polarized Scanning Electron Microscope (SEMPA)

NanoFabrication Research Laboratory
Direct Write Electron Beam Lithography (DWEBL) System
Double–Sided Contact Mask Aligner and Wafer Bonder System
Laser Pattern Generator/Mask Writer
Electron Beam Lithography and Photolithography Resist Processing Equipment and development tools
Plasma Etching and Deposition Equipment
Oxidation, Annealing, Diffusion and Low Pressure Chemical Vapor Deposition Furnaces
Thin Film Processing Equipment
Metrology and Inspection Tools
Ancillary Equipment

Nanomaterials Theory Institute
32-node Beowolf Cluster
7 SGI Graphic Workstations
16 screen video wall

General Use Equipment
X–ray Diffraction Laboratory for Multi–User Nanoscience
Focused Ion Beam (FIB) / Scanning Electron Microscope (SEM) (Dual–Beam System)
Laboratory Fume Hoods, furnishings, misc. equip.
Furniture and computers

		Equipment			Electrical			Heat Load (1 kW-hr=3412 BTUs)		Hoods						Water/Plumbing			
Location in Building (floor followed by location relative to lobby, beginning with 1)	**Description**	**Special Equipment located in labs? Line item**	**Est. max Equipment Weight during move in(lb) [total equip weight]**	**Special Requirements**	**Est kW of power load: Standard/lab 100 amp; 208/120V, 3-ph; 24 circ**	**480 V Req'd**	**3-phase power Req'd**	**Heat Load to Air**	**Heat Load to Water**	**Number being plumbed**	**Number installed**	**Hood Use**	**Type of Hood (Walk-in, Laminar, Fume, or Canopy) and Width**	**Chemical Storage Beneath**	**HEPA Filter required**	**plumb for sinks with H/C water/ number**	**sink with base unit installed**	**Dish washer with DI rinse**	**Vented toxic gas cabinet**
31	Anionic Polymerization Lab 1 (3-6-8)		<1,000 [<2,000]		25	No	No			3	3	2/3 open at any time; 50% use	1-(8ft.)Fume 1-(8ft.)Walk-in 1-(10ft.)Walk-in	Yes	No	1	1	1	No
32	Anionic Polymerization Lab 2 (3-6-7)	Annealing oven- to be moved	<1,000 [<2,500]		40	No	No			4	4	2/3 open at any time; 50% use	1-(8ft.)Fume 1-(8ft.)Walk-in 1-(10ft.)Walk-in 1 (7-ft) canopy	Yes	No	1	1	1	1 - (3 cylinder)
33	Synthetic Polymer Characterization (3-6-6)	High Temperature GPC	<1,000 [2,500]		25	No	No			3	2	2/3 open at any time; 50% use	2-(8ft.)Fume	Yes	No	1	1	1	No
34	Deuteration (3-6-5)	Gel Permeation Chromatography (GPC) and	<1,000 [2,500]		25	No	No			3	3	2/3 open at any time; 50% use	2-(8ft.) Fume 1-(8ft.)Walk-in	Yes	No	1	1	1	1 - (3 cylinder)
35	Free Radical / Block Copolymers (3-6-4)		<1,000 [<2,000]		25	No	No			3	2	2/3 open at any time; 50% use	2-(8ft.)Fume	Yes	No	1	1	1	No
36	Bio-based Synthesis Lab (3-6-3)		<1,000 [<2,000]		25	No	No			3	3	2/3 open at any time; 50% use	2-(8ft.)Fume 1-(10)Walk-in	Yes	No	1	1	1	No
37	Composites Lab (3-6-2)		<1,000 [<2,000]		25	No	No			3	3	2/3 open at any time; 50% use	2 - (8ft.) Fume 1-(8ft.)Walk-in	Yes	Possible	1	1	1	No
38	Inorganic Synthesis and Processing (3-6-1)		<1,000 [<2,000]		25	No	No			3	3	2/3 open at any time; 50% use	1-(6ft.)Fume 2-(8ft.)Fume	Yes	No	1	1	1	2 - (3 cylinder)
21	Chemical Vapor Deposition (CVD) Lab (2-6-8)	CVD systems (EXISTING Equipment)	<1,000		170	Option	yes	50-60kw		4	4	2/3 open at any time; 50% use	1-(8ft.)Walk-in 1-(4ft.)Fume 1-(5ft.)Canopy 1-(4ft)Laminar	Yes	Yes - 4-ft hood only	1	1	No	1 - (3 cylinder)
22	Mass Spectrometer Characterization (2-6-7)	MALDI time-of-flight spectrometer; DSC	<2,000 [2,500]		10	no	no	5kW eq		1	1		1 - (4ft.) Fume	Yes	No	1	1	No	1 - (3 cylinder)
23	Laser-Based Characterization (2-6-6)	Elipsometer, Static and Dynamic Light Scattering Spectrometer	<1,100 [3,000]		10	no	no			1	1		1 - (4ft.) Fume	Yes	No	1	1	No	No
24	Optical Characterization 1 (2-6-5)	FTIR, UV-VIS	1,100 [3,000]		10	no	no		<5KW eq	1	1		1 - (4ft.) Fume	Yes	No	1	1	No	No
25	Catalysis Characterization / Neutron Scattering (2-6-4)		<1,000 [5,000]		10	no	no		<10 KW eq	1	1		1 - (4ft.) Fume	Yes	No	1	1	No	2 - (3 cylinder)
26	Catalysis Characterization (2-6-3)	Surface characterization equipment (general, existing eq.)	<1,000 [5,000]		10	no	no	Normal Loads		1	1		1 - (4ft.) Fume	Yes	No	1	1	No	2 - (3 cylinder)
27	Catalysis Synthesis (2-6-2)		<1,000 [<2,000]		25	No	No			3	2		1-(8ft.)Fume 1-(6ft.)Canopy	Yes	No	1	1	No	No

		Equipment			Electrical			Heat Load (1 kW-hr=3412 BTUs)		Hoods						Water/Plumbing			
Location in Building (floor followed by location relative to lobby, beginning with 1)	**Description**	**Special Equipment located in labs? Line item**	**Est. max Equipment Weight during move in(lb) [total equip weight]**	**Special Requirements**	**Est kW of power load: Standard/lab 100 amp; 208/120V, 3-ph; 24 circ**	**480 V Req'd**	**3-phase power Req'd**	**Heat Load to Air**	**Heat Load to Water**	**Number being plumbed**	**Number installed**	**Hood Use**	**Type of Hood (Walk-in, Laminar, Fume, or Canopy) and Width**	**Chemical Storage Beneath**	**HEPA Filter required**	**plumb for sinks with H/C water/ number**	**sink with base unit installed**	**Dish washer with DI rinse**	**Vented toxic gas cabinet**
28	Catalysis Synthesis (2-6-1)		<1,000 [<2,000]		25	No	No			3	3		3 - (8ft.) Fume	Yes	No	1	1	No	2 - (3 cylinder)
11	Target Synthesis and Furnace (1-6-8)	(2) large box furnaces (1500 C) – 3' x 3' x 3', 400 lbs.; (2) medium box furnaces (1200 C) – 3' x 2.5' x 2.5', 80 lbs; (1) large tube furnaces (1500 C) – 3' x 2.5' x 2', 100 lbs; (2) small tube furnaces (1100 C) – 1.5' x 1' x 1', 25 lbs. (1) 250 ton press; (1) Weighing table (ALL EXISTING EQIPMENT)	400 [6,000]		80kW (208V, 1-ph, 60 amp)	no	no	40 kW eq. ave (24 hr); up to 80 kW periodically - canopy hoods		4	4		1- (6ft.) Fume 2-(7ft.) Canopy 1-(6ft) Canopy	Yes	No	1	1	No	No
12	X-ray Diffraction (1-6-7)	Four–circle diffractometer; Two-circle diffractometer;; X-ray fluorescence system; Laue system	2800 [8,400]		50	no	Yes, 208V		20 kW eq	1	None		None		No	1	1	No	No
13	Laser Nanomaterials Synthesis (1-6-5) & (1-6-6)	High power YAG Laser System ; Existing eq.: Double YAG laser system, ovens and collectors	2,000 [17,000]	connect 13 and 14	200kW (half is 208 1-Ph) total for double lab	100kW; 70 amps/ph , 480 V 3 ph	yes - both 480 and 208	20 kW eq (24 hr)	150kw eq (6 hrs op)	2	2		2- (8ft.) Fume	Yes	Yes	1	1	No	2 - (3 cylinder)
14	Laser Nanomaterials Synthesis (1-6-5) & (1-6-6)	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above		see above	see above	see above	see above	see above	see above	see above
15	Laser Diagnostics 1 (1-6-3) & (1-6-4)	Tuable Raman System (inc.Ti-sapphire ring laser); MOPO Laser; Existing lasers diagnostic equipment	1,500 [17,000]	Connect 15 and 16;	200 kW (mix includes 208V, 1-Ph and 208V, 3-Ph)total for double lab	50 kW; 60 amps	yes - both 480 and 208	20 kW eq (24 hr)	150kw eq (6 hrs op)	2	2		2 - (8ft.) Fume	Yes	No	1	1	No	1 - (2 cyllinder)
16	Laser Diagnostics 2 (1-6-3) & (1-6-4)	see above	see above		see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above
17	Pulsed Laser Deposition (PLD) #1 (1-6-1) & (1-6-2)	Existing laser equipment:Excimer laser Lambda Physik LPX305; Excimer laser Lambda Physik LPX325; Gas processor; (2) UHV Thermionics Laser-MBE systems; (5) PLD systems	1,700 (3,300 future eq.) [20,000]	connect 17 and 18	100 kW (170 amps at 115; some 208, 1-ph; total for double lab	No	yes, 208V, 200 amps (incl. future)		50kw eq (6 hrs op)	1	1		1 - (4ft.) Fume	Yes	No	1	1	No	2 - (3 cylinder)
18	Pulsed Laser Deposition (PLD) #2 (1-6-1) & (1-6-2)	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above	see above

		Equipment			Electrical			Heat Load (1 kW-hr=3412 BTUs)		Hoods						Water/Plumbing			
Location in Building (floor followed by location relative to lobby, beginning with 1)	**Description**	**Special Equipment located in labs? Line item**	**Est. max Equipment Weight during move in(lb) [total equip weight]**	**Special Requirements**	**Est kW of power load: Standard/lab 100 amp; 208/120V, 3-ph; 24 circ**	**480 V Req'd**	**3-phase power Req'd**	**Heat Load to Air**	**Heat Load to Water**	**Number being plumbed**	**Number installed**	**Hood Use**	**Type of Hood (Walk-in, Laminar, Fume, or Canopy) and Width**	**Chemical Storage Beneath**	**HEPA Filter required**	**plumb for sinks with H/C water/ number**	**sink with base unit installed**	**Dish washer with DI rinse**	**Vented toxic gas cabinet**
B1	NMR (B1-6-8)	NMR (contingency item) OR AFMs (existing equipment)	5,000{4,400]		15 kW	no	yes		<10KW eq	1	1		1 - (4ft.) Fume	Yes	No	1	1	No	No
B2	Nanomaterials Synthesis (B1-6-7)	tube furnaces (existing/future equipment)	1,000 [1,000]		30 kW (incl. 208V, 1-ph, 40 amp)	no	no		6 kW eq (1 hr intermit)	3	3		1-(8ft.) Fume 2-(8ft.)Walk-in	Yes	No	1	1	No	1 - (3 cylinder)
B3	Electro-/Optical-/Magneto Characterization (B1-6-6)	Spectrophotometer; Photolum. Excitation; Var-T Photolum. Spectrometer; Fluorometer [all existing/future eq]	1,780 [3,500]		20 kW	No	yes- 75 Amps; 208V	normal loads		1	1		1 - (8ft.) Fume	Yes	No	1	1	No	No
B4	Magnetic Imaging (B1-6-5)	4-tip STM w/ SEM/SAM; SPM/SEM/SAM and RHEED system (future)	2,500 [6,000]		25 kW	no	yes, 208V		< 10 kW eq	1	1		1 - (4ft.) Fume	Yes	No	1	1	No	No
B5	Magnetic Materials Growth and Characterization 1 (B1-6-3) & (B1-6-4)	SEMPA (Spin polarized SEM); UHV transport system w/laser MBE, linear MOKE,VT AFM/STM (existing, to be moved)	1,500 [10,000]	Connect B5 and B6	50 kW,total for double lab	no	yes - 1 circuit		10 KW eq (4 hr operation)	1	1		1 - (6ft.) Fume	Yes	No	1	1	No	1 - (2 cyllinder)
B6	Magnetic Materials Growth and Characterization 2 (B1-6-3) & (B1-6-4)	see above	see above		see above	no	yes - 1 circuit		see above	see above	see above		see above	see above	see above	see above	see above	see above	see above
B7	UHV Scanning Probes 1 (B1-6-1) & (B1-6-2)	Ultra LT Hig Mag Field STM (Under Dev); Low Temp, High Mag Field SPM and Scanning Near Field Optical Kerr (future)	2,500 [9,000]	Connect B7 and B8	50 kW,total for double lab	no	yes- 1 circuit		<10 kW eq.	1	1		1 - (4ft.) Fume	Yes	No	1	1	No	No
B8	UHV Scanning Probes 2 (B1-6-1) & (B1-6-2)	see above	see above		see above	no	yes- 1 circuit		see above	see above	see above		see above	see above	see above	see above	see above	see above	see above